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# **MECHANICAL-PROPERTY DATA**

## **TD NICKEL**

**Stress-Relieved Sheet**

**Issued by**

**Air Force Materials Laboratory  
Research and Technology Division  
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**July, 1966**

**Prepared by**

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This data sheet was prepared by Battelle Memorial Institute under Contract AF 33 (615)-2494. The contract was initiated under Project No. 7381, "Materials Application", Task No. 738106, "Design Information Development". The major objectives of this program are to evaluate newly developed structural materials of potential Air Force weapons-system interest and then to provide data-sheet-type presentations of mechanical data. The program was assigned to the Structural Materials Engineering Division at Battelle under the supervision of Mr. Walter S. Hyler. Project engineer was Mr. Leman Beall, Jr.. The program was administered under the direction of the Air Force Materials Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, by Mr. Marvin Knight, project engineer.

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## TD NICKEL

TD Nickel is a recently developed alloy containing 2 volume percent thoria and the balance nickel (Ni - 2ThO<sub>2</sub>). This alloy shows promise as a structural material for use in the temperature range from 1800 to 2400 F. It has excellent thermal stability, high thermal conductivity, and a high melting point.

The material has sufficient ductility for simple cold-forming operations and can be machined in the same manner as stainless steel.

Fusion welding requires special techniques to achieve sound joints. However, this alloy can be joined quite readily by brazing, ultrasonic welding, and diffusion bonding.

The alloy is available as sheet, bar, tubing, wire, foil, and forging.

### TD NICKEL SHEET DATA<sup>(a)</sup>

Condition: Stress-relieved<sup>(b)</sup>  
Thickness: 0.060 inch

Properties	Temperature, F			
	RT	1600	1800	2000
Tensile				
F <sub>tu</sub> (longitudinal), ksi	63.6	21.4	17.9	14.7
F <sub>tu</sub> (transverse), ksi	63.8	20.6	17.1	13.3
F <sub>ty</sub> (longitudinal), ksi	46.2	21.2	17.7	14.3
F <sub>ty</sub> (transverse), ksi	45.6	20.3	16.8	12.9
e <sub>t</sub> (longitudinal), percent in 2 in.	14.5	5.0	5.0	8.0
e <sub>t</sub> (transverse), percent in 2 in.	14.5	3.0	3.0	3.0
E <sub>t</sub> (longitudinal), psi x 10 <sup>6</sup>	16.9	10.7	9.1	8.2
E <sub>t</sub> (transverse), psi x 10 <sup>6</sup>	17.8	10.3	8.8	8.6
Compression				
F <sub>cy</sub> (longitudinal), ksi	42.1	20.9	17.2	13.6
F <sub>cy</sub> (transverse), ksi	49.4	20.3	16.1	12.8
E <sub>c</sub> (longitudinal), ksi	16.0	9.5	9.9	7.7
E <sub>c</sub> (transverse), ksi	18.4	9.7	9.9	7.4
Impact				
(V-notch Charpy) ft-lb(l)*	30	NA <sup>(c)</sup>	30	NA
Fracture Toughness				
	(d)	NA	NA	NA
Bend				
(Transverse)	Sharp <sup>(e)</sup>	NA	NA	NA

Properties	Temperature, F			
	RT	1600	1800	2000
<b>Shear, <math>F_s</math></b>				
(Longitudinal), ksi	57.9	NA	NA	NA
(Transverse), ksi	58.4	NA	NA	NA
<b>Axial Fatigue</b>				
(Transverse)				
$10^3$ ( $K_t = 1$ ) ( $R = 0.1$ ), ksi	63.0	23.0	19.0	NA
$10^5$ ( $K_t = 1$ ) ( $R = 0.1$ ), ksi	57.5	19.5	16.0	NA
$10^7$ ( $K_t = 1$ ) ( $R = 0.1$ ), ksi	45.0	15.0	11.5	NA
$10^3$ ( $K_t = 3$ ) ( $R = 0.1$ ), ksi	61.0	22.5	17.0	NA
$10^5$ ( $K_t = 3$ ) ( $R = 0.1$ ), ksi	59.0	15.0	12.0	NA
$10^7$ ( $K_t = 3$ ) ( $R = 0.1$ ), ksi	22.5	10.0	8.0	NA
<b>Creep</b>				
(Transverse)				
0.2% elongation 100 hr, ksi	NA	10.0	7.2	4.6
0.2% elongation 1000 hr, ksi	NA	8.2	5.2	3.5
<b>Stress Rupture</b>				
Rupture 100 hr, ksi	NA	11.0	7.8	5.4
Rupture 1000 hr, ksi	NA	9.0	5.8	4.4
<b>Stress Corrosion</b>				
80 percent $F_{ty}$ 1000 hr max	No cracks <sup>(g)</sup>	NA	NA	NA
<b>Coefficient of Thermal Expansion</b>				
68 to 2000 F	$8.7 \times 10^{-6}$ in./in./F			
<b>Density (1,2)*</b>	0.322 lb/in. <sup>3</sup>			
<b>Ductile-to-Brittle Bend-Transition Temperature, F</b>	Lower than -100 F <sup>(f)</sup>			
<b>Melting Temperature</b>	2650 F <sup>(3)</sup>			

Notes: Thermal conductivity, Btu/h<sup>2</sup>/in./hr/1°F

at 70 F	- 600 (2,3)
500 F	- 380
1100 F	- 300
1500 F	- 320
1700 F	- 340

Electrical resistivity, microhm-cm (70 F) 7.6 (2,3)

Specific heat, Btu/lb/°F 0.106 (2,3)

\* References are given on page 7.

(a) Data are average values.

(b) Treatment: 1 hr. at 2000 F in hydrogen. Test material from two production heats.

(c) Information either not available or not applicable.

(d) Fatigue-cracked center-notched specimens ( $0.060 \pm 3^\circ \times 12^\circ$ ) failed in a ductile manner.

(e) Sharp bending Tup (75-deg angle); specimen unloaded bend angle over 100 deg; no cracks at RT.

(f) Sharp bending Tup (75-deg angle); no cracks at -100 F.

(g) Alternate immersion 2% NaCl.

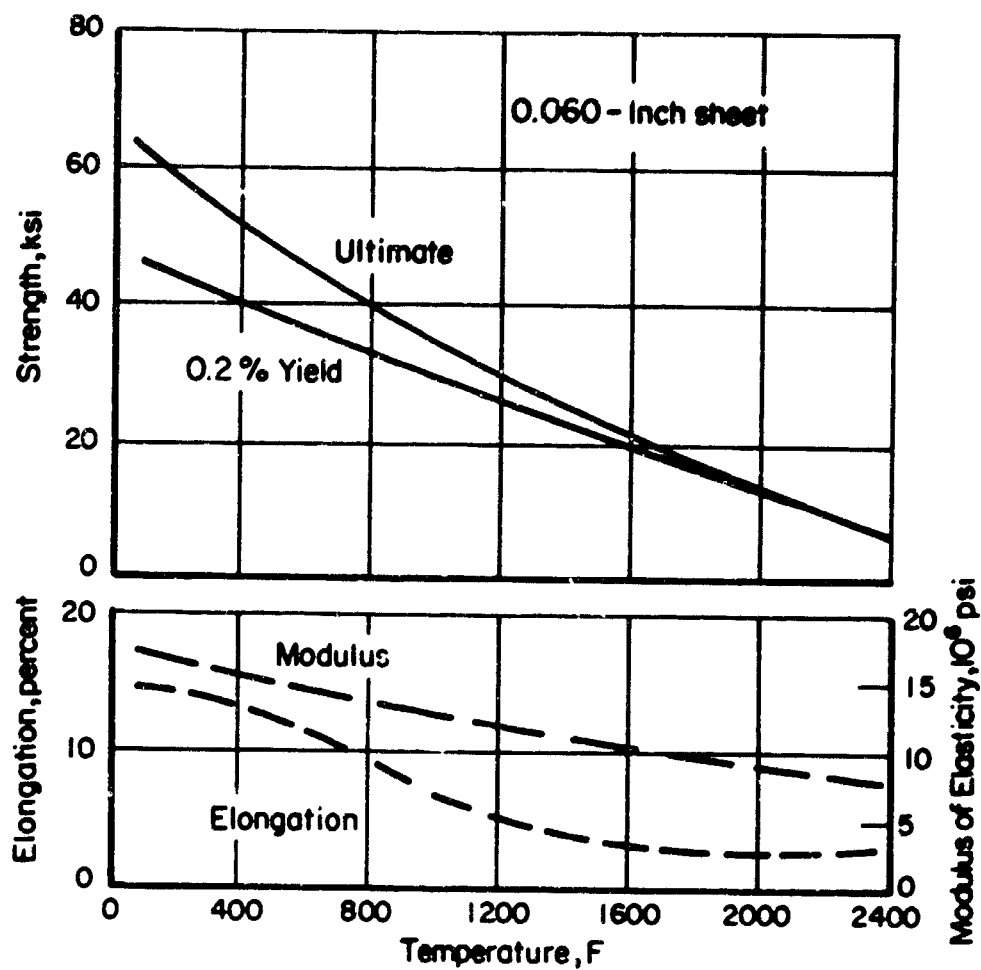


FIGURE 1. EFFECT OF TEMPERATURE ON THE TENSILE PROPERTIES OF STRESS-RELIEVED TD NICKEL SHEET

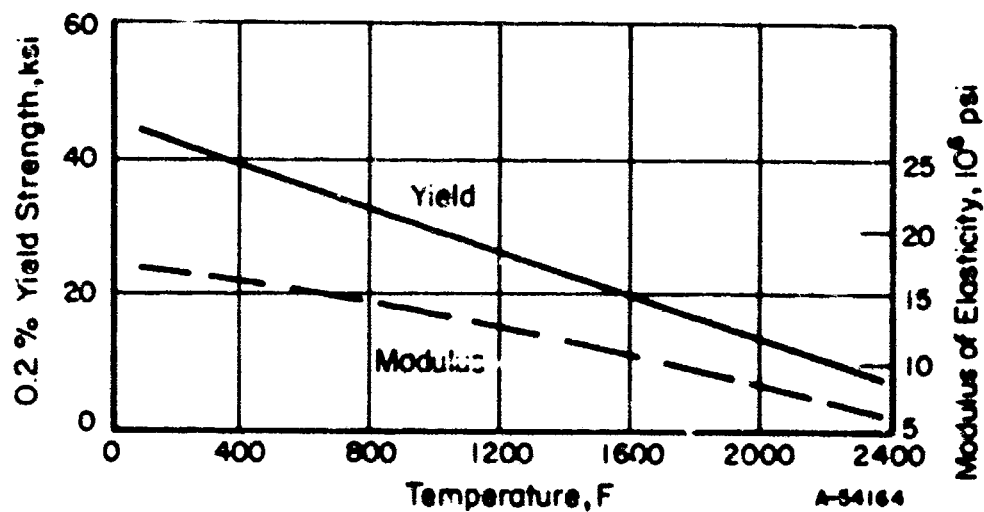


FIGURE 2. EFFECT OF TEMPERATURE ON THE COMPRESSION PROPERTIES OF STRESS-RELIEVED TD NICKEL SHEET

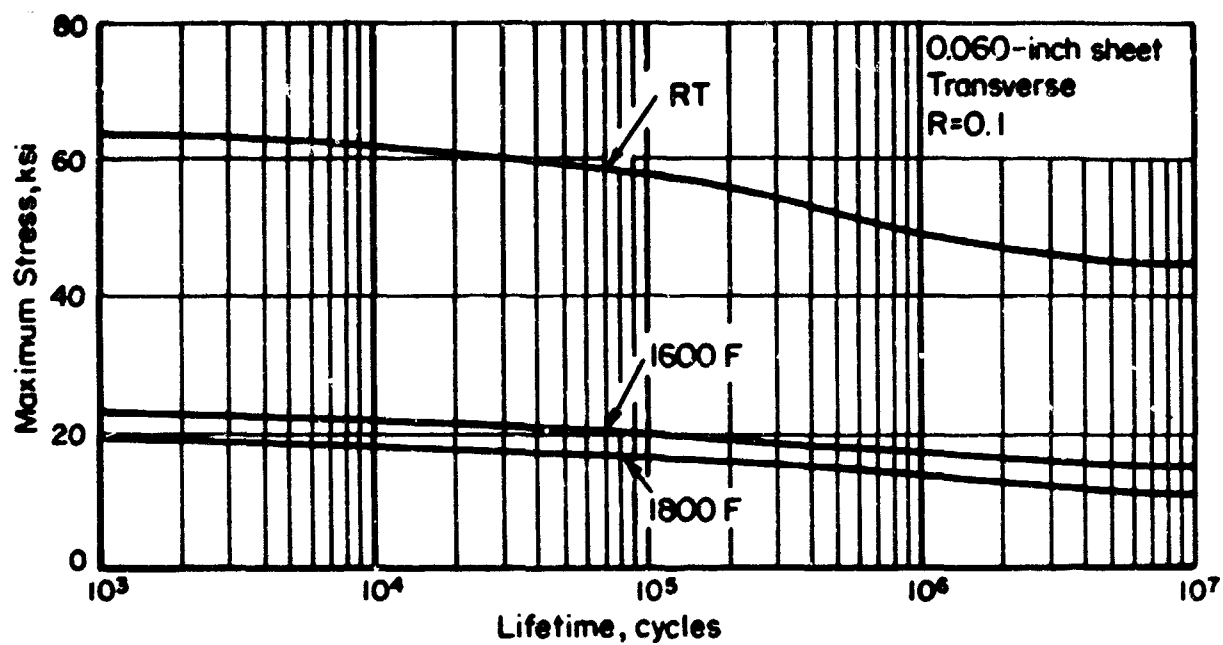


FIGURE 3. AXIAL-LOAD FATIGUE RESULTS FOR STRESS-RELIEVED TD NICKEL SHEET AT THREE TEMPERATURES

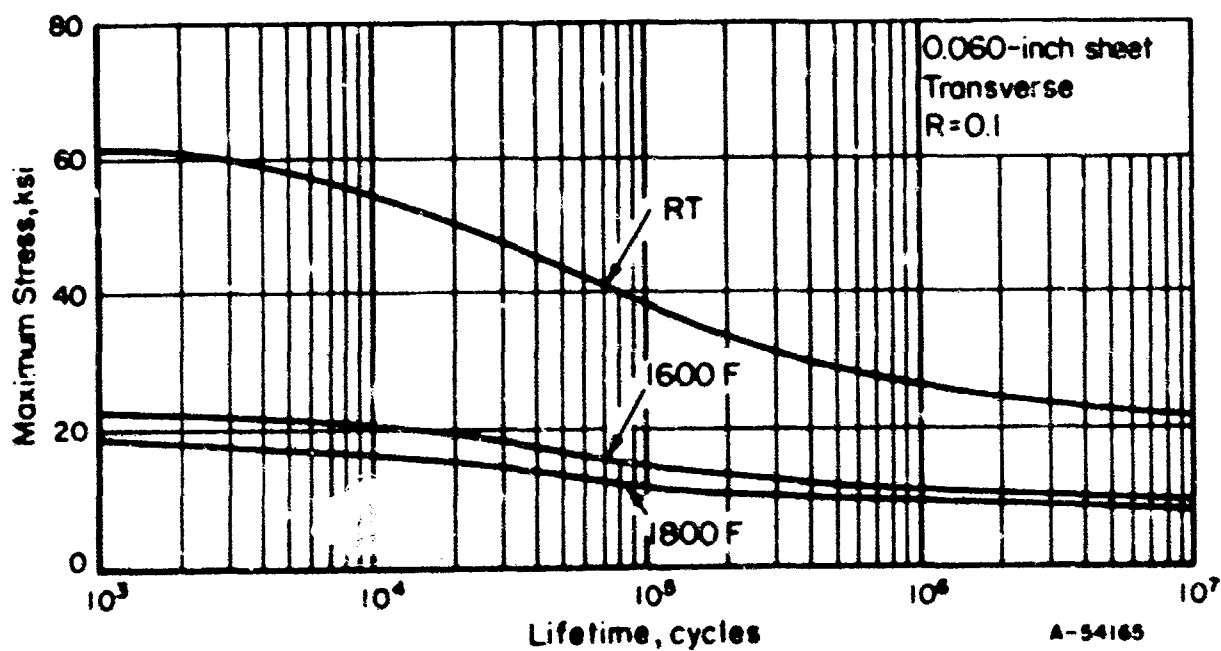


FIGURE 4. AXIAL-LOAD FATIGUE RESULTS FOR NOTCHED ( $K_t = 3.0$ ), STRESS-RELIEVED TD NICKEL SHEET AT THREE TEMPERATURES

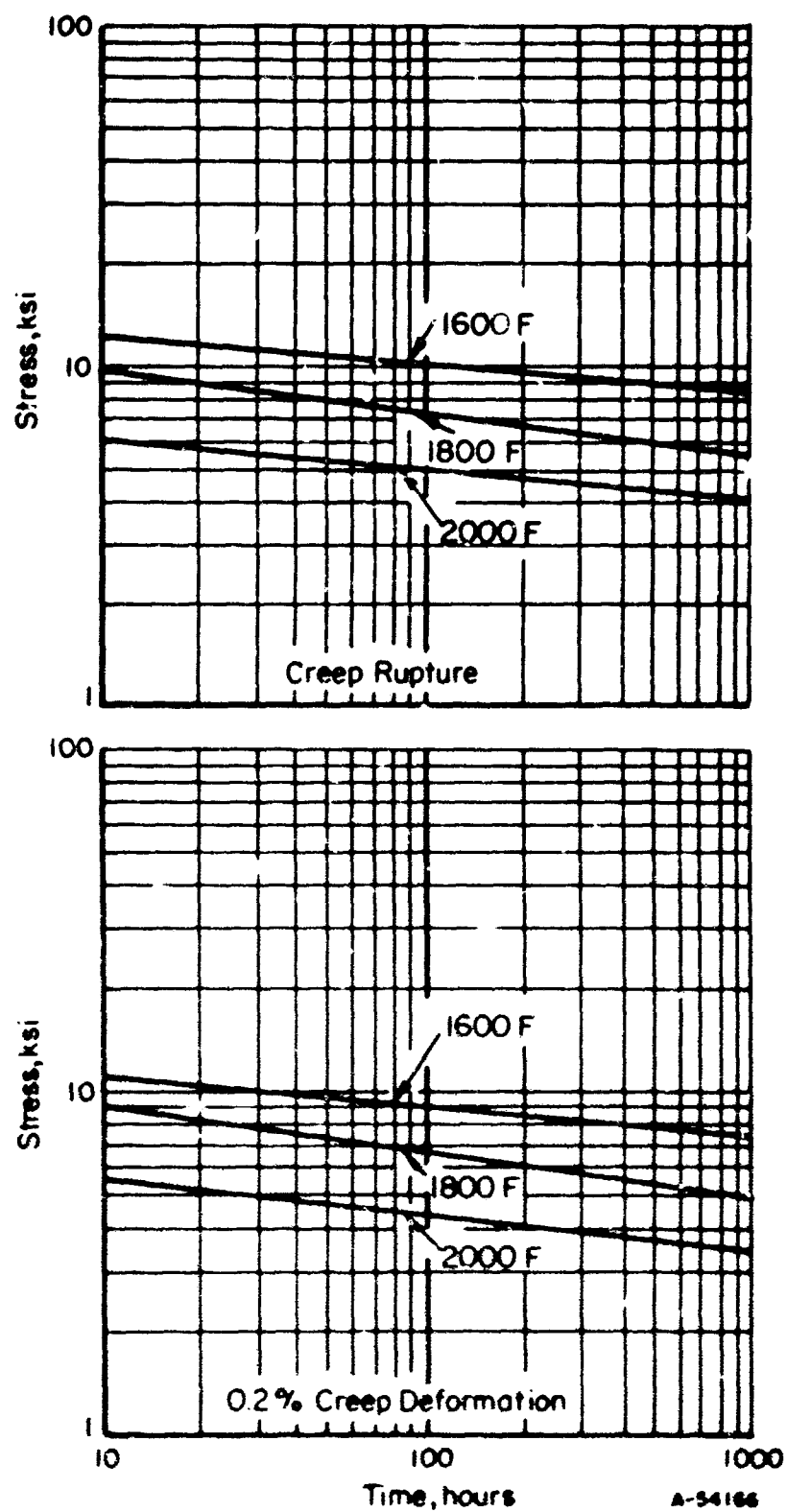


FIGURE 5. STRESS-RUPTURE AND 0.2% DEFORMATION CURVES FOR TD NICKEL SHEET (0.060 INCH) AT THREE TEMPERATURES

#### REFERENCES

- (1) Anders, F. J., Jr., Alexander, G. B., and Wartel, W. S., "A Dispersion-Strengthened Nickel Alloy", Metal Prog., 82 (6), 88-91, 118-122 (December, 1962).
- (2) "TD Nickel Dispersion Strengthened Nickel", Report A-41076, Du Pont Metal Products - Product Information, undated.
- (3) Stuart, R. E., and Starr, C. D., "New Design Data on TD Nickel", Mater. Design Eng., 58 (2), 81-85 (August, 1963).

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
crossed interferometers fundamental and harmonic frequency asymmetric gases methylene chloride, methylene fluoride, and difluoroethylene coaxial tunable magnetron beam splitters						

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